

Abstract: Interactive effects of carbon dioxide, water, and nitrogen on grassland ecosystem processes

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(1) Objectives. The proposed research focuses on how inputs of water to terrestrial ecosystems interact with atmospheric CO₂ and soil nitrogen (N) supply to affect ecosystem structure and function. While many experiments have examined the impacts of various global change factors in isolation, predicting the future course of biosphere function, including biosphere-atmosphere interactions, requires understanding how these factors interact to affect ecosystems. Particularly lacking are studies of how altered precipitation interacts with other global change factors to impact biophysical and biogeochemical processes. Our overarching objective is therefore to conduct a long-term field experiment that manipulates water, CO₂ and N; to measure biological and physical responses to address linked hypotheses about water, CO₂ and N interactions; and to publish our findings in peer-reviewed papers.

(2) Location. A new factorial experiment will be established by incorporating manipulations of precipitation into an ongoing global change field experiment of atmospheric CO₂ and simulated atmospheric N deposition in a temperate perennial grassland experiment at the Cedar Creek research site in Minnesota.

(3) Hypotheses. Our proposed experiment is explicitly designed to test underlying theory regarding the relative importance of multiple resource interactions (among water, CO₂ and N) on C, N and water dynamics, interactions that can only be elucidated using carefully planned experiments. For example, for net primary production we predict that the elevated CO₂ (*e*CO₂) effect will be greatest when both water and N are abundant because plants are then relatively more C limited rather than water or N limited; also in this treatment N availability (via enhanced N mineralization) is enhanced. Stimulation of NPP by *e*CO₂ still occurs but is constrained when either water or N are limited, due to co-limitation (cf multiple resource theory) being a larger effect than the water savings from *e*CO₂-induced reductions of leaf conductance; when both water and N are least available, the *e*CO₂ effect will be zero or very small.

(4) Approach. We will use free-air CO₂ enrichment, soil N additions, and precipitation removal (using portable rain-out shelters) to expose open-grown established experimental grassland plots to all combinations of two levels of each factor. We will assess hypotheses about the interactions among these three factors by measuring a suite of responses developed from prior studies at this site.

(5) Intended accomplishments (including deliverables). We intend to effectively conduct the experiment, to analyze, interpret and synthesize the data, and to publish peer-reviewed scientific articles that disseminate our findings.